

## Science 9

### Reproduction

## History of theories of the Cell

Aristotle (4th century BC)- believe in spontaneous generation (abiogenesis)- non-living things will be transformed into living things.



- Francisco Redi (1668)- he suggested that living things do not come from non-living things, they come from other living things



- John Needham (1713-1781)- microscopic living things can come from non-living things
- Lazzaro Spallanzani (1729-1799)- microscopic living things did not come from non-living things

- Louis Pasteur (1822-1895)- living things come from living things not non-living things.

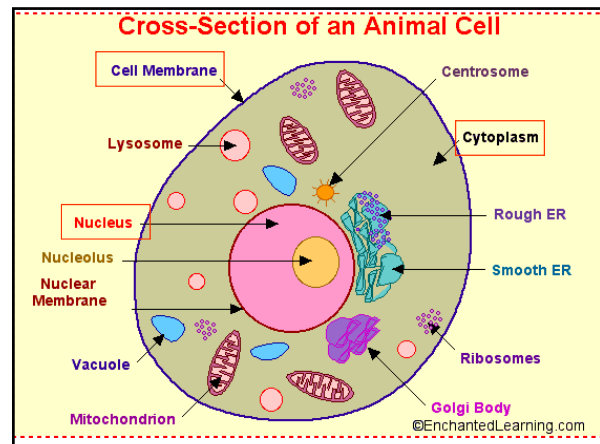
### Cell theory

1. All living things are composed of one or more cells
2. The cell is the functional unit of life
3. All cells come from pre-existing cells

- Scientific Theories are accepted ideas about certain things
- Scientific theories are used as long as they explain what we see.
- When evidence is found that does not agree with the theory, the theory is modified for the new evidence
- If there is too much evidence that disagrees with the theory, the theory may be thrown out
- Scientists are constantly looking at new experiments to challenge theories

## Key Parts of the Cell

- Cells are made up of many organelles
- Cell membrane- 'the gatekeeper', controls movement in and out of the cell.



- Nucleus- 'control centre', directs the cell's activities
- Chromosomes- 'the architects', organize the genetic information into threads
- Genes- 'Blueprints', the specific characteristics inside a chromosome

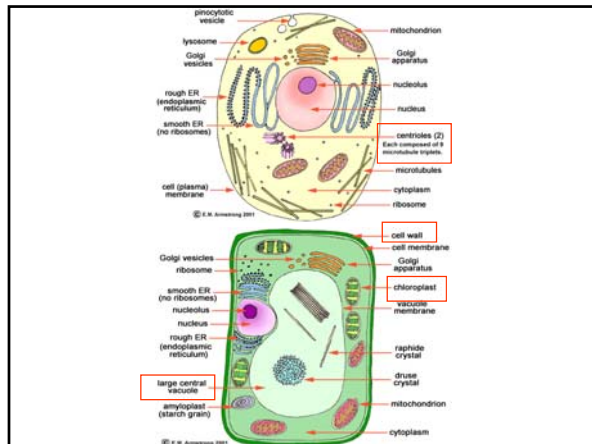
- Cytoplasm- 'Work area'- area inside the cell where the work is done

## Plant and animal cells

- -Animal cells and plant cells contain some different structures from each other.

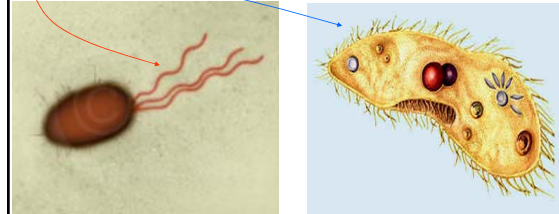
## Plant and animal cells

- | <u>Animal cells</u>  | <u>Plant cells</u>  |
|--|---|
| <ul style="list-style-type: none"> <li>• <u>Centriole</u>- 'the fertilization clinic'- used for cell division</li> </ul> | <ul style="list-style-type: none"> <li>• <u>Cell wall</u>- 'the fortress'- rigid material (cellulose) that protects and supports the cell</li> <li>• <u>Chloroplast</u>- 'the baker'- makes sugar through photosynthesis</li> <li>• <u>Enlarged Vacuole</u>- 'The warehouse'- Area in the cell that stores food and water. The vacuole is much larger in a plant cell than an animal cell.</li> </ul> |



## Cell Movement

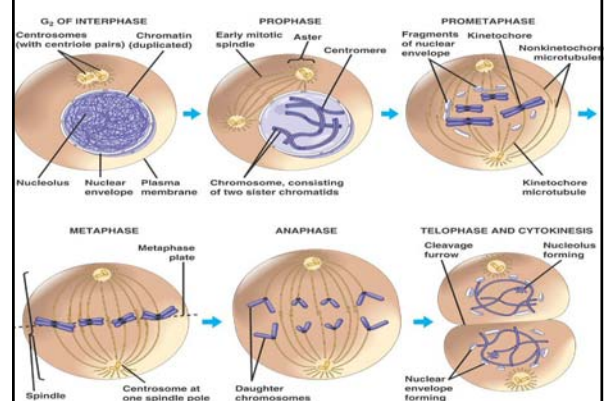
- -If cells need to move, they would use:
- **Flagellum**-‘the whip’- a tail used like rudder
- **Cilia**-‘the oars’- tiny hairs that move the cell



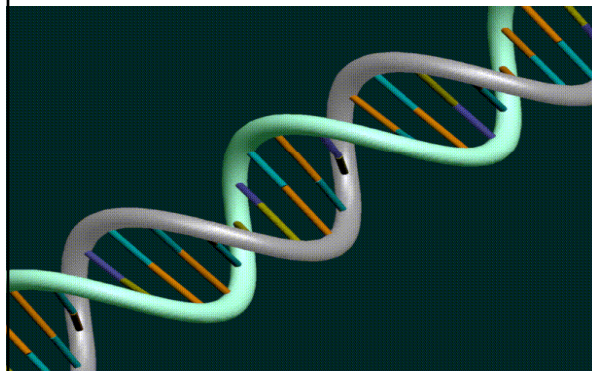
## Importance of cell division

- Reasons why cells divide
- -Healing and repairing injuries
- -Growing
- -Reproduction

## Mitosis



## DNA



## Cancer

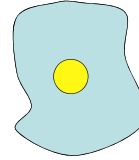


## Reproduction

- There are 2 distinct ways that living organisms can reproduce
- 1. Asexual reproduction
- 2. Sexual reproduction

## Asexual Reproduction

- When the offspring is genetically identical to the parent

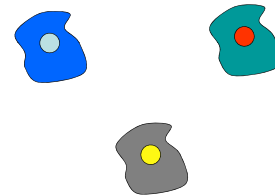


## Asexual Reproduction

- In times of abundance, asexual reproduction allows a species to produce many organism in a short period of time.
- With very limited genetic diversity, the risk of disease is greatly increased.

## Sexual Reproduction

- Two sex cells unite to form a unique cell (zygote).

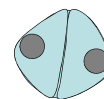


## Sexual Reproduction

- Finding a mate to join cells can be difficult limiting the chances for reproduction.
- Genetic diversity provides the species with a greater chance of survival.

## Types of Asexual Reproduction

- There are several types of asexual reproduction.
- Binary fission- organism splits directly into two equal-sized offspring, each with the parent's genetic material.
  - Occurs in bacteria and other single-celled organisms



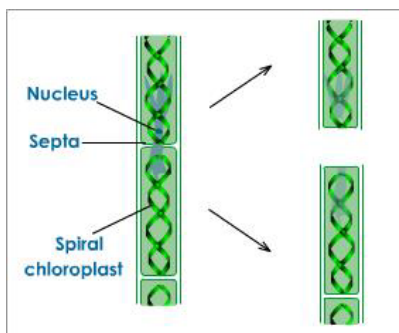
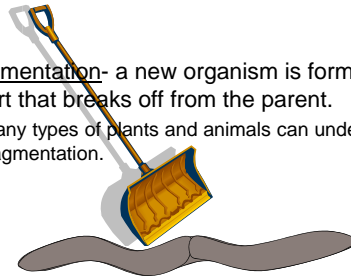


BIODIDAC • J. Houseman

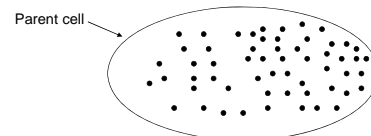
- **Budding**- offspring begins as a small outgrowth of the parent and eventually breaks off, becoming an organism on its own.
  - Occurs in some single-celled organisms like yeast but also in some multi-celled organism like Hydra

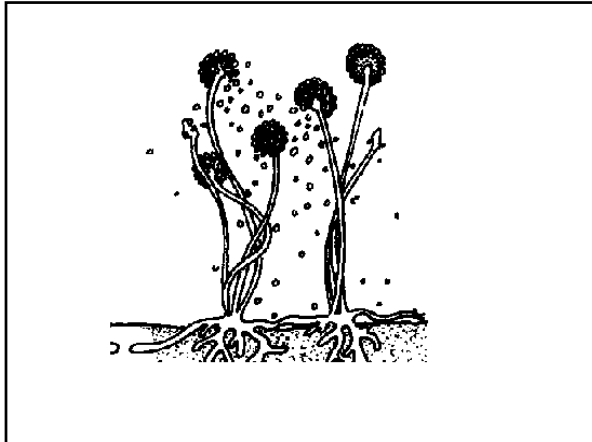


- **Fragmentation**- a new organism is formed from a part that breaks off from the parent.
  - Many types of plants and animals can undergo fragmentation.

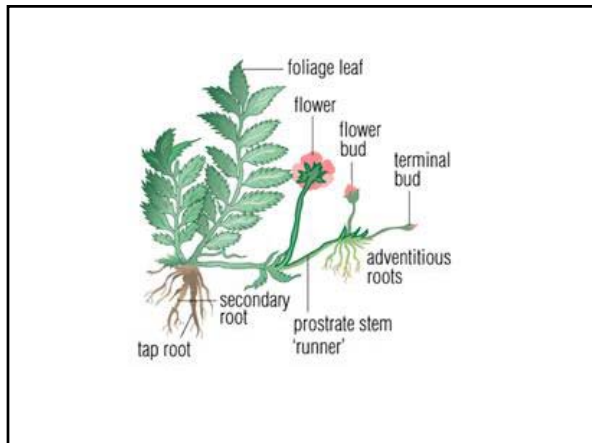
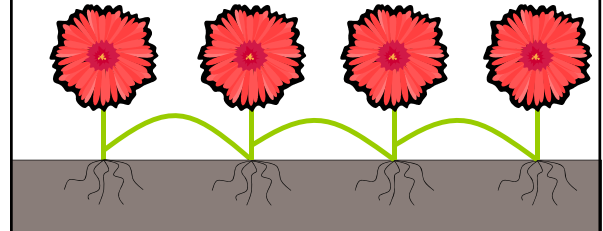


- **Spore formation**- the organism undergoes cell division to produce smaller identical cells, called spores, that are usually housed in the parent cell.
  - Occurs in many plants and fungus.





- Vegetative reproduction- a section of a plant grows to form a new plant.



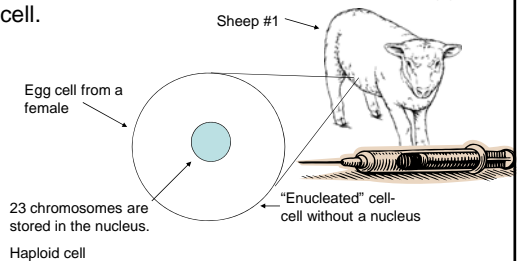
## Asexual plant reproduction

- Plants can be reproduced asexually in many ways
  - Stem cutting
  - Leaf cutting
  - Leaf-section cutting
  - Root division
  - Runners
  - Tubers

## Cloning

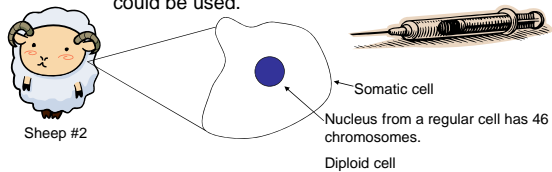
- When identical offspring are formed from a single cell or tissue.
- There are many forms of cloning but we will look at the basic step of cloning a complex organism.

1. Remove the nucleus from an unfertilized egg cell.

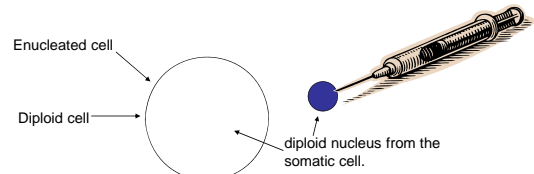


2. The nucleus of a somatic cell is removed.

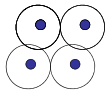
- Somatic cell- any cell other than a sex cell. (regular cell).
- Originally it was thought that only embryo cells could be used.



3. The diploid nucleus from the somatic cell is inserted in the enucleated cell.



4. Cells undergo cell division.

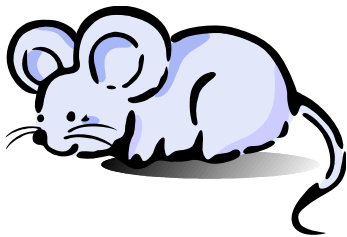


5. Cells are implanted in a surrogate.

- The surrogate will raise the embryo until birth



## Clone your own Mouse



<http://learn.genetics.utah.edu/content/tech/cloning/clickandclone/>

## Stem cells

- A stem cell is an undifferentiated cell that can reproduce into any type of cell.
  - Blood cell
  - Bone cell
  - Muscle cell
  - Etc.



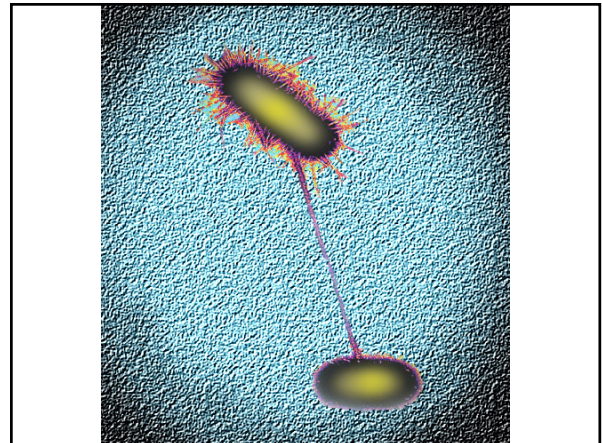
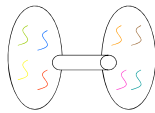


## Sexual Reproduction

- There are 3 main strategies used in sexual reproduction.
  1. Conjugation
  2. Hermaphrodites
  3. Separate sexes

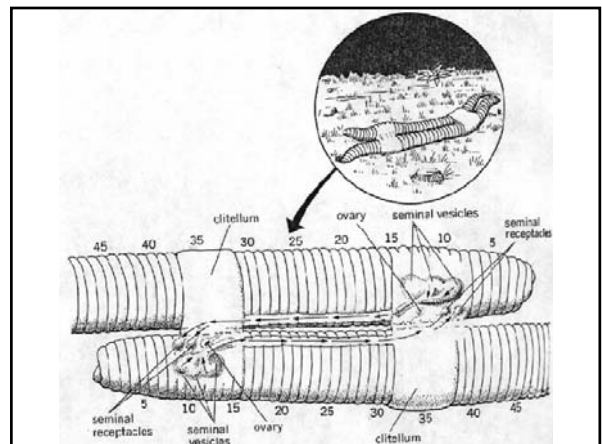
## Conjugation

- Conjugation occurs when single celled organisms (bacteria) join together and exchange small pieces of their genetic information.
  - 2 cells create 2 genetically different cells



## Hermaphrodites

- Sexual reproduction when the organism contain both male and female sex cell.
- Every organism can produce a unique offspring.
  - Very few organism can self fertilize.
  - Can occur with immobile organism (sponges, tomatoes) or some burrowing organisms (earthworms)







## Separate Sexes

- Sexual reproduction when there are organism that produce male sex cells and a separate organism that produces female sex cells.
- Only half the population can produce the unique offspring.

## Separate Sexes

- There are 2 methods of fertilization with separate sexes.
  - External fertilization- when the sex cells unite outside of the female's body.
    - Ex. fish
  - Internal Fertilization- when the sex cells unite inside the female's body.
    - Ex. human

## Sexual Reproduction and Chromosome Number

- In a regular human cell, we have 46 chromosomes (2 pairs of 23).
  - We call this a diploid cell ( $di = 2$ ). 2 sets.
  - Given the symbol  $2n$ .
- In a human sex cell, we have 23 chromosomes (1 set of 23)
  - We call this a haploid cell. Half the chromosomes.
  - Given the symbol  $n$ .

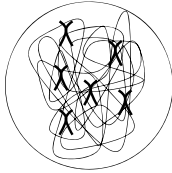
- In mitosis, all the chromosomes were duplicated and transferred to the next cell.
- For sex cells, the chromosome number has to be cut in half.
- This is done through the process called meiosis.

## Meiosis

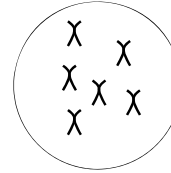
- Meiosis follows several similar steps to mitosis
- 1. Chromosome duplication- all the chromosomes make an exact duplicate.



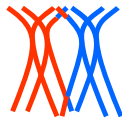
2. Chromosomes shorten and thicken like in prophase.



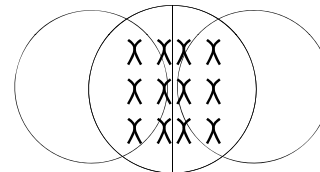
3. Chromosomes pair up with their matching chromosome at the equator of the cell.



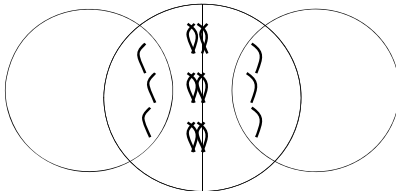
4. The chromosomes cross over at certain points and exchange genes.  
– This helps increase genetic diversity.



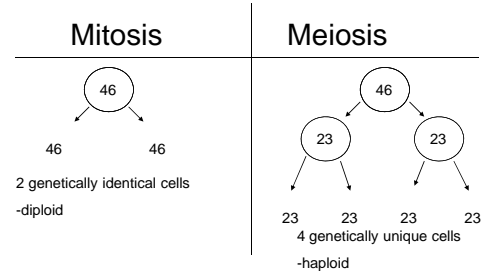
5. The pairs of chromosomes divide into separate cells



6. Chromosomes align along the equator and divide like in mitosis.



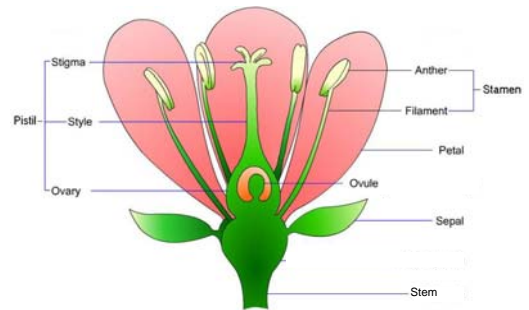
- The result is 4 unique, haploid cells (half the chromosome number)



## Flower Reproduction

- A flower is the reproductive part of a flowering plant.
- There are many parts to a flower and they serve specific purposes.

## Parts of the Flower



## Parts of the Flower

**Ovule**- The structure that contains the reproductive cells. It later becomes the seed.

**Ovary**- The structure that contains the eggs. The ovary later becomes the fruit.

**Stamen**- The male reproductive structure of the flower. Contains the anther and filament.

**Filament**- Long stalk that supports the anther.

**Style**- The stalk that carries the pollen grains to the ovary.

**Stigma**- The top of the pistil. It exudes a sticky material that captures pollen.

**Anther**- the place where the pollen grains are produced. The pollen grain are the male sex cells.

**Stem**- The support and elevation for the flower

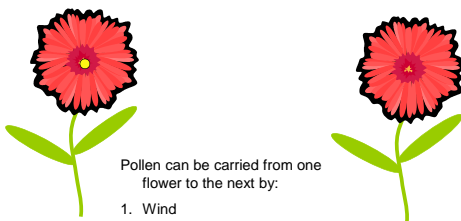
**Pistil**- The female reproductive structure. It is often shaped like a flask.

**Petal**- The coloured leaf-like structure of most flowers. Meant to attract other organisms.

**Sepal**- The green leafy pieces of the flower that protect the flower while it is in the bud stage

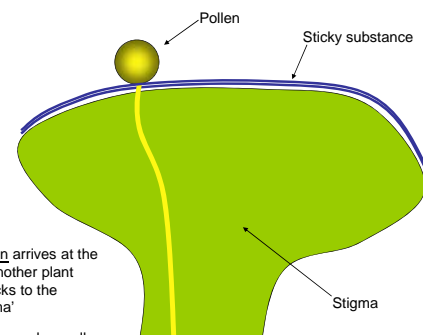
## Flower Reproduction

- Most flowers contain both male and female parts.
  - The flower is designed so that the plant cannot self-pollinate.
1. Flower reproduction begins when pollen travels from the anther to the stigma of another plant.



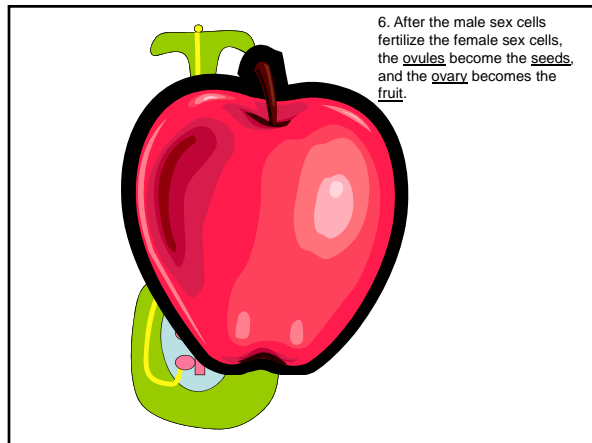
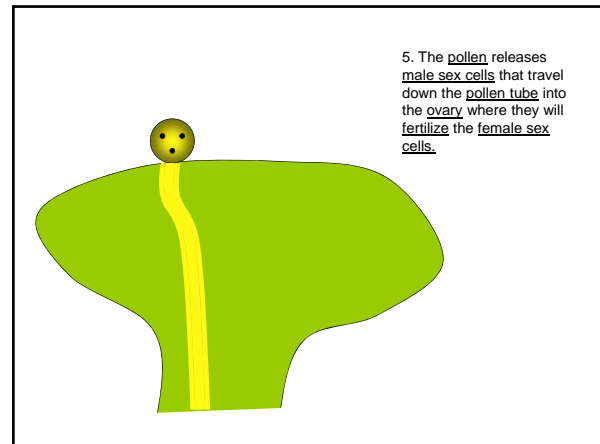
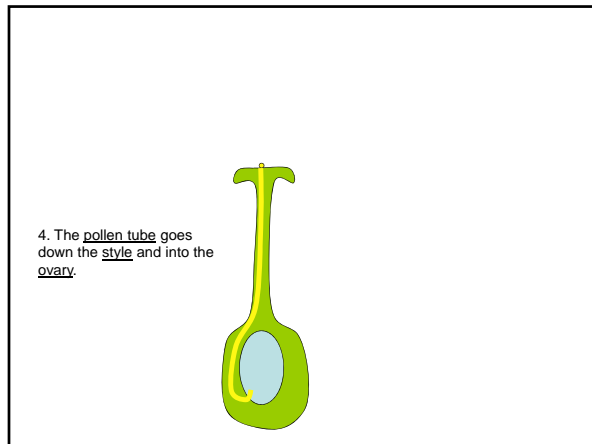
Pollen can be carried from one flower to the next by:

1. Wind
2. Insect
3. Animal



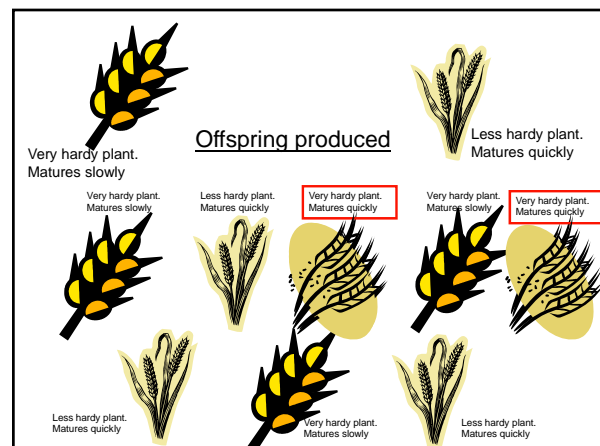
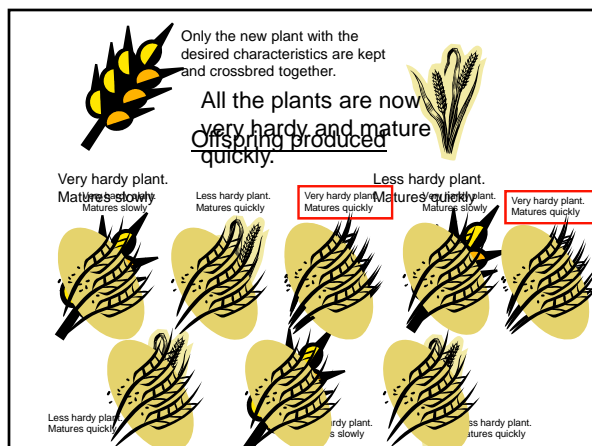
2. The pollen arrives at the stigma of another plant where it sticks to the 'sticky stigma'

3. The pollen sends a pollen tube down the style of the flower



## Selective Breeding

- When plants with desired characteristics are identified and crossbred with other plants having different desirable characteristics.
- After several generations, all the offspring have the desired characteristic.
- A risk of selective breeding is low genetic diversity.
  - Species may be more susceptible to disease.



Only the new plant with the desired characteristics are kept and crossbred together.

Very hardy plant.  
Matures quickly



## Asexual Plant Reproduction Techniques

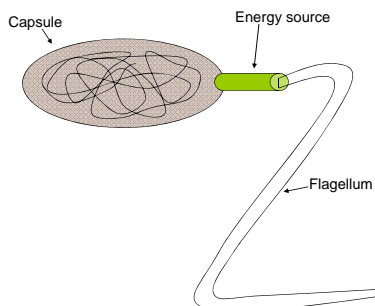
- There are asexual methods to reproduce plants with desirable characteristics.
  - Cloning- Cuttings from one plant are used to produce more plants.
  - Grafting- Desirable branches are grafted (attached) to plants with desirable root systems.

## Human Reproduction

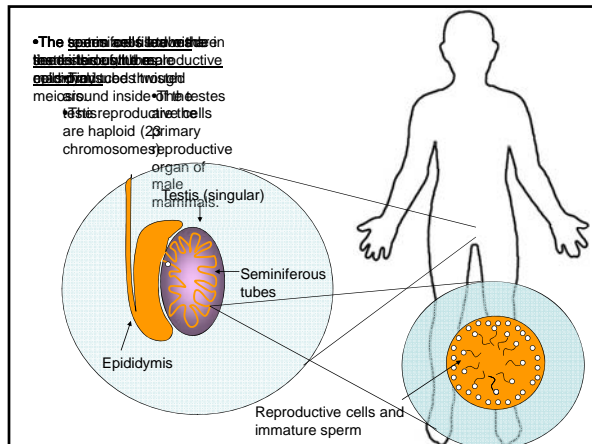
- Human reproduction uses separate sexes.
- There are two sexes that contain different sex cells.

## Male Reproduction

- The male sex cell is known as a sperm cell.
- It is made up of 3 parts:
  1. Capsule (head)- contains chromosomes to be transferred.
  2. Energy source- There is just enough energy stored to make the trip for fertilization.
  3. Flagellum- used to propel the sperm cell.

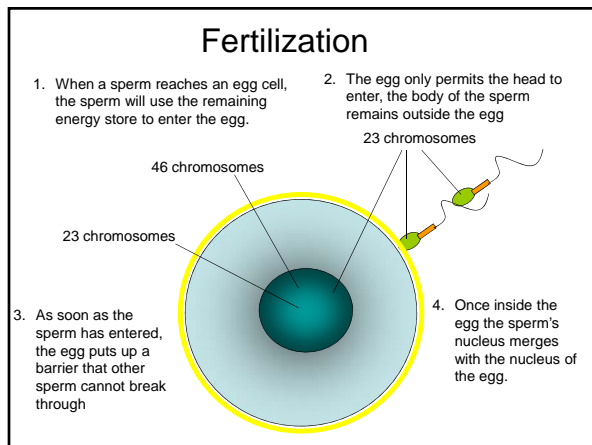


- The sperm cells are made in the testes of the male mammal.
  - The testes are the primary reproductive organ of male mammals.
- The testes are filled with seminiferous tubes.
  - Tiny tubes twisted around inside of the testis
- The seminiferous tubes are lined inside with reproductive cells produced through meiosis.
  - The reproductive cells are haploid (23 chromosomes)



## Fertilization

- When a sperm reaches an egg cell, the sperm will use the remaining energy store to enter the egg.



## Hormones

- A hormone is a chemical that acts as a messenger in between cells.
- Up until about 7 weeks, male and female embryos are identical.
- Testosterone is released in males that stimulates the development of male sexual structures.

## Hormones

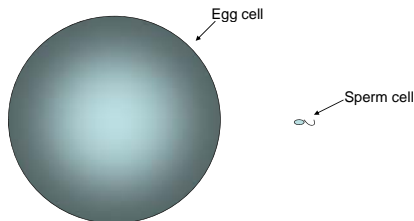
- At puberty (9- 15 years of age) the amount of testosterone production is increased.
- Testosterone is released from the testes.
- There are other important hormones produced by males.
  - Luteinizing hormone (LH)- causes special testes cells to produce testosterone.
  - Follicle stimulating hormone (FSH)- causes reproductive cells in the testes to divide and produce sperm cells. Also causes reproductive cells to absorb testosterone.

## Reproductive Ages

- Males are able to produce sperm from the time of puberty for the remainder of the male's life.

## Female reproduction

- The female sex cell is called the egg cell.
- The egg cell is much larger than the sperm cell.



## Female reproduction

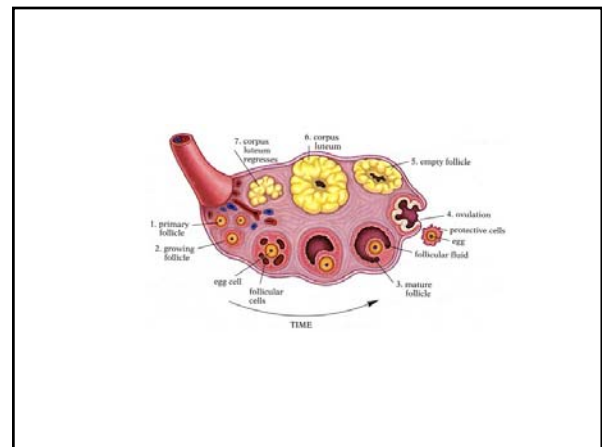
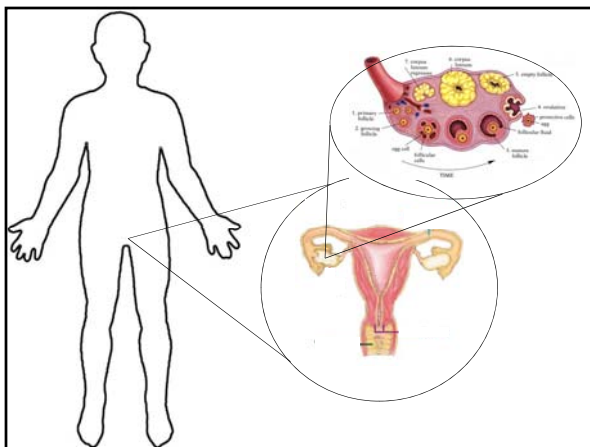
- The egg cell is packed with nutrients so it can divide rapidly.
  - The sperm cell only lasts a few days.
- Only one egg cell is produced at a time.
  - Millions of sperm cells are produced every day.

## Female Reproduction

- The primary reproductive organ of the female is the ovary.
- Inside the ovary we will find follicles
  - small groups of cells
- The follicles contain 2 types of cells:
  - Reproductive cells that produce the egg.
  - Nutrient producing cells that provide energy for the developing egg.

## Female Reproduction

- There are only about 400 000 follicles at puberty but most do not reach maturity.
- Hundreds of follicles may begin to develop each cycle, but only 1 is allowed to reach maturity each reproductive cycle.
  - The rest deteriorate and are absorbed into the ovary.

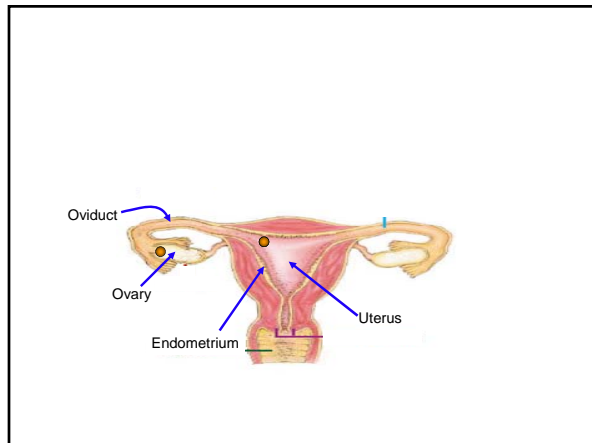




- As the follicle develops, the reproductive cell which begins with 46 chromosomes, undergoes meiosis.
- It will develop one large egg cell (23 chromosomes) and 3 cells that disintegrate.
- Nutrient cells surrounding the egg have been dividing to nourish the egg.
- The nutrient cells develop a fluid filled cavity around the egg.
- When the egg is ready, the ovary wall bursts and the egg is released into the oviduct.

•The release process is called ovulation.

- Nutrient cells that remain in the ovary are transformed into corpus luteum.
- Corpus luteum produces hormones necessary for pregnancy.
- If pregnancy does not occur, the corpus luteum breaks down after about 10 days and the cycle leading to ovulation begins again.



- When the egg is released from the ovary, it moves into the oviduct, which moves the egg towards the uterus.
- If the egg was fertilized, the zygote begins to divide by mitosis, becoming an embryo
- The embryo embeds itself in the thick lining of the uterus, call the endometrium.
- If the egg is not fertilized, the endometrium is shed in a process called menstruation.

## Hormones

- Along with LH and FSH there are 2 key hormones produced by females for reproduction are:
  - Estrogen- Encourages the endometrium to thicken in preparation for the zygote.
    - As the follicles develop, the estrogen levels in the blood increase.
  - Progesterone- stimulates the development of the endometrium and prepares the uterus for an embryo.
    - Progesterone inhibits further ovulation

## Reproductive Ages

- Females continue the reproductive cycle from puberty (9- 15 years) until menopause (40- 55 years)

## Reproductive Technology

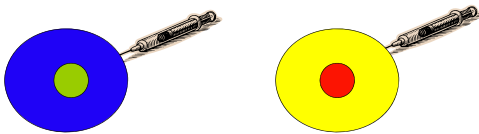
- Technology has helped many people conceive children that otherwise may not have conceived.
- There are many social and moral issues around reproductive technology.

## Fertility Drugs

- Fertility drugs create hormonal conditions that increase the chance of conception.
- Fertility drugs generally increases the amount of eggs released which increases the chances of multiple births.

## Cytoplasmic Transfer

- Transferring the cytoplasm from a younger female's egg into an older female's egg cell.
- Helps reduce the probability of genetic defects that occur in pregnancies of older females.



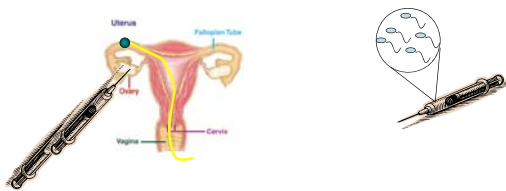
## Intrauterine Insemination

- Sperm is transferred directly into the oviduct of the female.
- This ensures that a great number of sperm cells reach the egg.



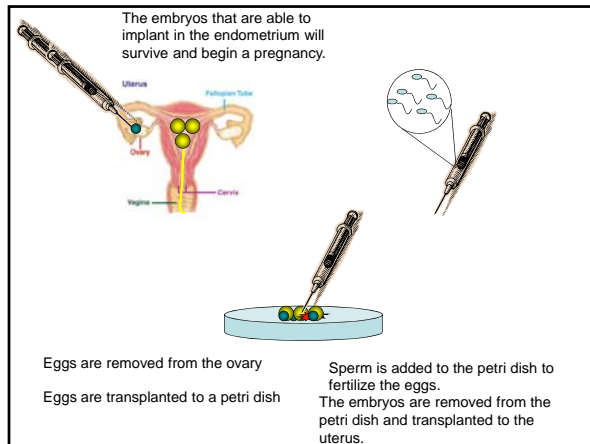
## Gamete Intrafallopian Transfer

- The sperm and egg are inserted into the oviduct.
- Increases the chance of fertilization by bringing the sperm and egg together.



## In Vitro Fertilization

- Eggs are removed from the female's ovary and are fertilized by the male's sperm in a petri dish.
- Several embryos are implanted in the female's uterus in hopes that at least one implants.
- Multiple births are very common through In Vitro fertilization.



## Egg Freezing and Egg Donations

- Eggs can be removed from the females ovary and frozen for use at a later date.
- Zygotes can also be frozen to be implanted at a later date.
- Eggs can be thawed and re-implanted in the female or may be transferred to a different female.

## Embryo Transfer

- Women with a defective uterus or cervix can have her embryo implanted into a surrogate female for the pregnancy.
- The fertilization occurs In Vitro with the egg and sperm of the original partners.

## Contraceptive Technologies

- Science has provided many ways to prevent fertilization of the egg by a sperm.
- We will discuss some of these technologies, but there are many other technologies that are also available.
- See handout.